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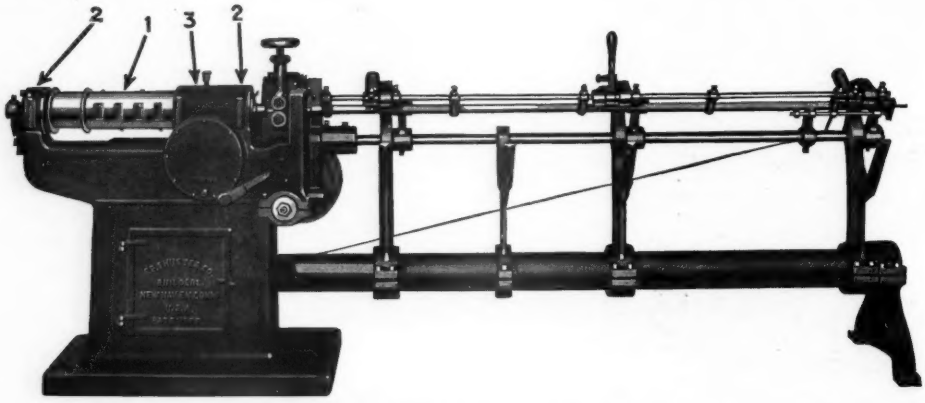

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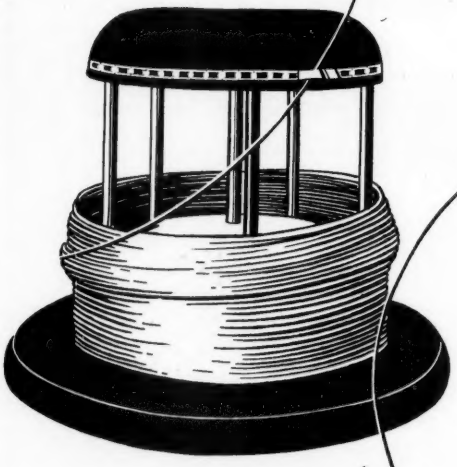

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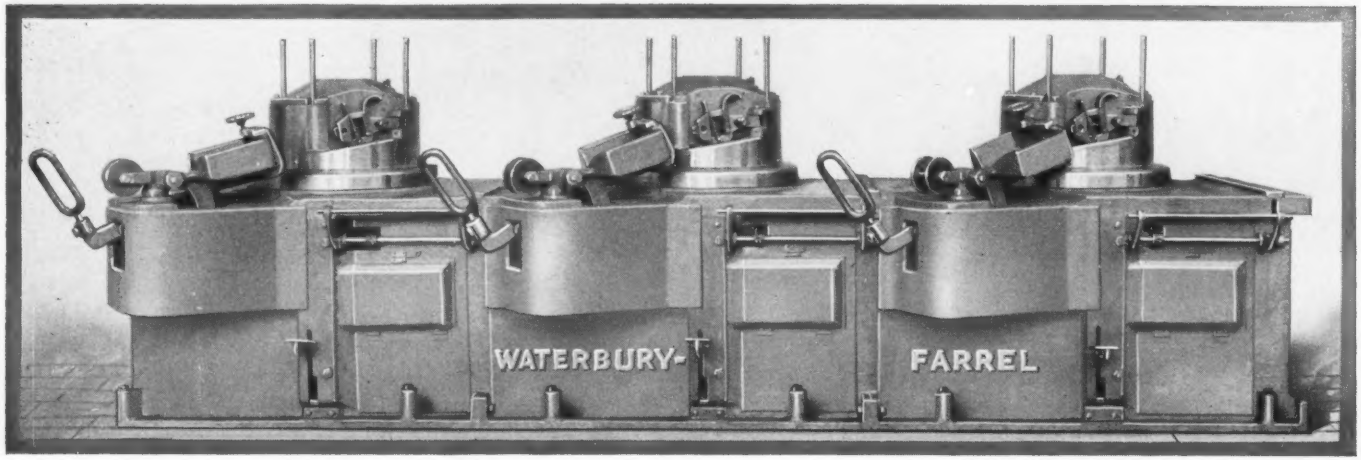

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WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 2 December, 1927 No. 12

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WIRE
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Vol. 2 DECEMBER, 1927 No. 12

Silver-Plating Wire by the Continuous Method

By Harrison B. Williams

SILVER Plated Wire as used in the arts is made by several different methods the most important today being the product made by electroplating a base metal, usually copper, with a thin coating of pure silver prior to the final drawing operations. Among the methods of making such a product by other means than plating are—

The sweating of silver foil on the outside of a small billet or rod which is subsequently reduced in diameter to the drawing die size by rolling or swaging. This art is very ancient and the present practice in India is not different from that of medieval Europe and ancient Rome except that diamond dies imported from Europe have supplanted the iron and steel dies formerly used. The method of securing a perfect bond between the core and the silver or gold shell of foil is to pack in a fire of charcoal until a weld is obtained.

A method in use principally in the jewelry trade where production costs much greater than in the electro-plating process are justified by a product of better wearing qualities, is the so called Gold Filled or Silver Filled method. In this method a shell of seamless drawn silver is filled with molten platers metal and, after the sawing off of the piped end caused by the shrinkage of the molten metal in solidifying the billet, is reduced to drawing size by swaging. The minimum percentage of silver possible in the wire made by this method is ten percent. This does not compare very favorably with the one percent silver wire possible by the electropating method and such one percent is now made capable of withstanding drawing through sixteen dies and then rolling to a ribbon four times the diameter of the wire and about one fourth diameter thick without injuring the integrity of the plating.

Plated-Ribbon Method

A very clever method of making silver plated wire has been in use for some time in the Providence district. In this method a sheet of copper or other base metal is electro-plated and then cut into a continuous ribbon by means of the circular shear to be described in these pages in a subsequent article on the manufacture of zinc wire. This ribbon of base metal with a silver plating on one side is then drawn through a die forming it into a round rod with the silver plated side on the outside. Subsequent drawing entirely cold welds the seam and there is an almost perfect fusion or cold weld of the silver coating at the joining edges in the finished product. Production cost however does not permit this method to compete with electroplating of silver wire and its use is only an economic answer to the high cost of silver filled wire where the difficult art of continuous silver plating of wire has not been solved.

In the final solution of the problem of how to silver plate wire much treasure has been expended and during the late war there was hardly a manufacturer of copper wire in the country that at some time or other did not attempt to solve the problem. That the problem was difficult may be seen when the facts are considered. First the plating must be of such a nature that it will stand drawing through a large number of dies. Otherwise the amount of equipment necessary to plate a given amount of wire would be out of all proportion to the commercial

value of the product and the overhead on equipment would be prohibitive. Then there is the question of whether to plate wire in the coil or skein or continuously. The former method where attempted proved impractical. The plating was necessarily not uniform and the product was a failure. Continuous plating presented difficulties hard to conceive unless one has been through it. There is the question of whether to plate one wire at a time or many. What bath to use. What pre-treatment of the wire to resort to. What amperage. What voltage. What speed to employ in drawing the wire through the bath. How to feed the wire into the bath hold it there and bring it out again. How long to keep a given part of the wire under the plating bath. How to get the current into the wire or rather out of it for the wire is of course the cathode. What anodes to use and whether to use soluble silver anodes or insoluble carbon ones. What distance to have the anodes from the wire and how many to use.

European Practice

There are three general answers to these problems. The European type plating machine uses an acid bath a very high voltage, one wire in each bath and insoluble anodes. In the European type machine the electrolyte a standard acid solution is held in small trays a few inches wide and about twelve inches long. The anodes are of carbon placed on the sides and bottom of the tray. The voltage used in high, running from ten to fifteen and the amperage, controlled by individual rheostats, is all that the wire will stand without annealing. Because of this if for any reason the machine is stopped the current must first be shut off as the portion of the wire between the bath and the cathode wheel or guide will burn off very quickly at the operating amperage if the short period that the wire is electrified, is increased by a very few seconds. As the bath is depleted during the run it is made up to strength by the addition of silver in acid solution. The advantages of this method are ease of control, freedom from cyanide danger and possibility of eliminating skilled labor, and technical supervision. The dis-advantages are low output per unit and plating inferior in quality to cyanide plating which is capable of very much more subsequent drawing after the plating operation.

The Large Tank Acid Method

A method also based upon the acid silver bath but yielding a far higher output per unit is the large tank acid method. In the large tank method the bath is contained not in a dish holding a few cubic inches of solution but in a wood tank eight to fourteen feet long and from twenty four to thirty six inches wide being deep enough to permit a solution depth of about twelve inches. In the large tank acid method one or more wires may be plated at the same time but one wire is infinitely easier to control than more than one as no matter how much care is employed in the arrangement of the insoluble carbon anodes and in the arranging of the path of travel of the wires through the solution, the tendency of the current to seek out one wire and deposit a larger quantity of silver upon it than upon any of the others is very difficult to control. In fact without the isolation of the cathode terminals and the use of an ammeter in each of the isolated circuits together with a resistance to cut back the current in any wire that has a tendency to run up, the method is inoperable.

Other articles on electroplating wire and the manufacture of tinsel will appear in early issues of Wire & Wire Products.

Returning to the large tank acid method when one wire is plated the wire is led from a reel or spool through an iron tank of hot caustic to remove any grease that may be present. Following the caustic bath the wire passes through a tank of preferably hot water. It next should pass through a tank of acid dip which may be any of the standard dips used in silver plating and then it is led into another tank of hot water. From this last tank it passes over a guide and into the plating tank proper containing the acid silver solution. At each end of this tank and fully submerged is a wood roll of such diameter that the size of wire being plated will not be given a set in passing around it. The wire is strung back and forth between the two rolls from four to six times and is led out of the tank over a metallic guide which is connected to the plating circuit on the cathode side. The question of whether to pass the wire into a tank of hot water at this stage to remove the plating solution always carried out of the plating tank by the capillary attraction of the wire, or whether to allow it to go to the spooler wet with plating solution depends upon the output of the plant in question and whether the amount of silver solution thus recoverable warrants the operation.

Rolls and Guides

The wire will draw without difficulty even though the solution is allowed to dry upon it. The mechanism for drawing the wire through the series of tanks requires some provision for obtaining a constant drawing and must be capable of speed variation through a wide range. It is of the utmost importance that in the arrangement of guides and rolls used to keep the wire in place from the supply coil or reel to the final winding up or pulling drum there be no point where the wire will be given a permanent set due to passing over a roll of smaller diame-

(*Continued on page 440*)

The Manufacture of Insulated Cables in France

PART IV

Lead covering and armoring

By George Kessler

(Translated from La Technique Moderne by Samuel Rosch)

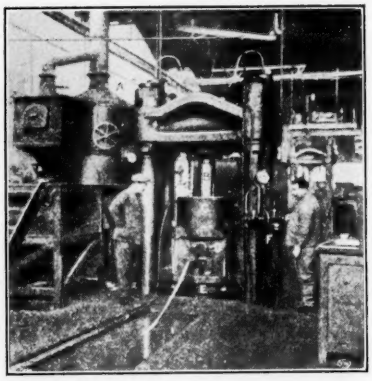

Fig. 1—Champigneul Lead Press. A, lead furnace—B, plunger—C, lead cylinder—D, die-block—E, hydraulic ram—F, operating valves.

Lead Covering and Lead Presses

Presses used for lead covering are of various types, the oldest, for example of the type of Francois Borel or of Siemens, have almost been abandoned. A horizontal type of press known as the Huber type, built in Germany, has been in very great demand in Central Europe for some time, some installations having also been made in France. The type most extensively used in France, is that of Champigneul, built by the S. O. M. U. A. (see fig. 1).

The Champigneul press of the vertical type, is extremely well built, and is based on the following principle. A stationary hydraulic cylinder situated at the lower end of the press, is surmounted by a strong arch supported by means of four steel columns. On the top of the hydraulic ram E is placed the lead block D, which forms the lead sheath. On the top of this block is placed the lead container or lead cylinder C. The lead plunger B is stationary and is bolted under the arch of the press.

When the hydraulic ram E (see fig. 1) is in its lowest position, the opening at the top of the lead container C is disengaged, so that it can be filled with molten lead which, not only fills the cylinder, but also fills the lead block D which is connected to the cylinder.

When the hydraulic pressure is applied, the movable parts, consisting of the hydraulic ram, lead block and lead container move vertically upward, while the lead is being forced down through the block by the fixed plunger P (see fig. 2). This block has the form of a rectangle prism cut in a horizontal plane through the middle. It is provided with a chamber of the proper form and dimensions. In this chamber are placed on the one hand a core, having the form of a perforated shell prevented from recoiling under the effect of the exerted pressure, by means of a strong hollow screw ending in a hexagonal nut, (the hollow in the nut, screw and core, are used for the passage of the cable), and on the other hand, a hollow mandrel receiving a die whose inner diameter corresponds to the outer diameter of the core, and to the required wall of lead.

When the lead is compressed in the container, it becomes equally compressed and starts moving from the special chamber in the lead block and is extruded through the only available space, namely, the space between the core and the die. The coarse adjustment of the wall of lead is accomplished by advancing or receding the core, but in order to obtain a finer adjustment, the die is moved along a fixed plane. This die is maintained in its final position by means of steel wedges placed in four corners, and controlled externally by four screws. It is sufficient to loosen or tighten these wedges at any corner, in order to effect a very sensitive displacement of the die, in the direction desired. In this manner, it is very easy to regulate the thickness of the wall of lead to within about a hundredth of a millimeter.

The following is the way the press works.

Mounting the block, filling the cylinder with molten lead, slight compression of the lead during the period of partial solidification (this is hastened by passing cold water through the water jacket around the container) then the natural upward movement of the movable system (the formation of the lead sheath) without however actually allowing the plunger to reach the bottom of the lead container; then reverse the operation by causing the movable system to travel downward until the opening at the top of the lead container is once more ex-

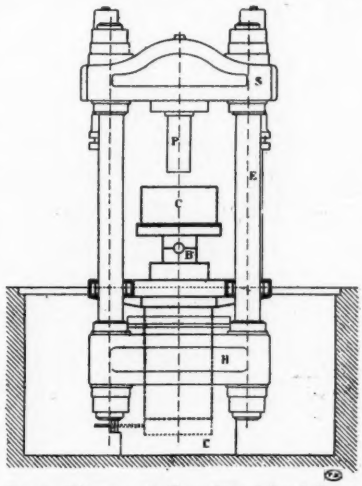

Fig. 2—Diagram of Champigneul Lead Press. B, die-block—C, lead cylinder—F, press columns—H, hydraulic ram—P, plunger—S, arch.

posed, refill with molten lead and start the partial solidification of the lead. This completes one cycle, the others being but a repetition of what we have just described.

Properly speaking, a lead press for cables is nothing but a press for the making of lead tubes. However, the arrangement in the block, allows the cable which is to be lead covered, to pass through. This sheathing may fit very loosely as in the case of telephone cables through which air is circulated, a little tighter in the case of cables with rubber insulation, or as tight as desired in the case of impregnated paper cables. It all resolves itself simply to the diameter of core and die used.

The motion of the cable through the press is accomplished by means of the advancing of the lead tube as fast as it is being formed. All that is necessary, is to start the cable through the core. The length of a lead tube and by the same token the length of cable to be lead covered, is infinite. During each cycle of operation, the molten lead solders itself to the remnant in the container, without any visible indication of the soldering or the formation of longitudinal or transverse cracks in the sheath. The only thing noticeable, is a slight contraction and discoloration of the sheathing which is due to the stopping of the compression of the lead.

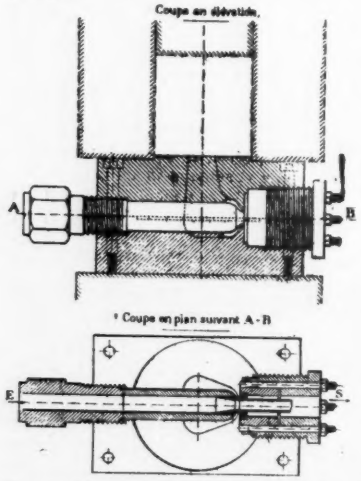

Fig. 3—Cross-section through die-block of Champigneul press. E, entrance of the cable core—S, exit of lead tube.

With a press of 1700 metric tons pressure, having a container 250 mm. in diameter and 750

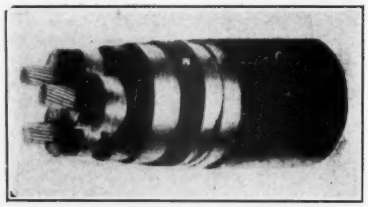

Fig. 4—Equi-potential cable armored with steel tapes.

mm. in height, the lead consumption is about 350 kg. of lead during each cycle or charge.

The lead press includes several indispensable accessories such as:

A hydraulic pump for producing a pressure of 450 kg. per sq. cm. driven by an electric motor, the regulation and operation of which are within the easy reach of the press operator.

A furnace for melting the lead, situated at the side of the press, in which the lead is kept constantly a little above the melting point. This furnace is provided at its lower portion, with an opening which enables the lead to be emptied into the lead cylinder, by means of a movable trough or pipe.

An automatic electrically operated variable speed reel stand, for receiving and turning the reels upon which are to be wound the cables which are leaded.

In back of the press:

A vat for impregnated cables, or a heated chamber for telephone cables which are filled with dried air.

A submerged pit containing cold water, in which the leaded portion of the cable is submerged, prior to being wound on the reel.

An installation of cold water, for circulating within the water jacket surrounding the lead container.

An installation of gas for heating the lead block, operating valves for the hydraulic pressure, and water at high pressure.

The Champigneul presses, are built in four types namely, 300 metric tons, 900 to 1000 metric tons, 1700 to 2000 tons and 3000 metric tons.

Blocks of different descriptions are used according to the diameter of the core, as follows: 68,80,120 and 165 mm. It is possible therefore to manufacture lead tubes or to lead cover cables from 4 to 115 mm. outer diameter.

We shall see in a later chapter entitled "Tests", that the lead sheathing of cables requires great care and what troubles we are liable to encounter. Generally pure lead is used in lead covering a cable, but in several cases as for example, in the case of telephone cables or cables which are suspended in the air, the lead is alloyed with a small quantity of tin or antimony to increase its hardness.

Armoring

The cables having been lead

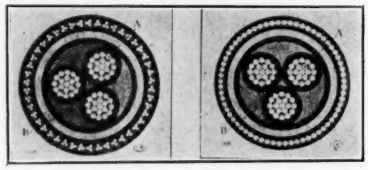

Fig. 5—Cross-section of three-phase cable armored with steel strands.

Fig. 6—Cross-section of three-phase cable armored with steel wires.

covered are next tested according to the service requirements, but we will speak of the tests in a later chapter. For the sake of argument, we will consider that the cables have satisfactorily met the various preliminary tests and are now ready to go on with the next operation.

Armoring consists in providing a mechanical protection over the lead sheath, the type of the protection varying with the conditions under which the cable is to operate. For lead sheathed cables drawn directly into ducts, it is only necessary to cover the lead with a layer of asphalted jute or fabric, in order to protect it. The same type of covering applies to single conductor cables operating on alternating current, but, for electrical reasons. (This is due to the heating of the armor wires by the currents induced in them).

Lead covered cables which are intended for operation directly

in the soil, may be armored by steel tapes wound in the same direction, the tapes being applied with an overlap. There are also provided layers of protective fibrous material such as asphalted paper or jute over and under the layers of steel tape. (see fig. 4). Cables laid in soils more or less moist, may be armored with ordinary cold rolled or hot rolled steel, according to the thickness. (This varies from 0.5 to 1.5 mm.)

For small diameter cables, the steel tapes are replaced by a layer of steel wires, each wire being in itself made up of a number of strands. When the soil is continually moist, the wires are galvanized and the protective layers underneath and over the armor wires, are further reinforced by layers of asphalt impregnated tapes.

Submarine cables, which have to have a definite tensile strength to resist the force of the water currents, and which also have to be protected against mechanical injury which may be caused by the dragging of iron hooks or anchors, are provided with an armor of high tensile strength consisting of stranded instead of solid galvanized steel wires (see fig. 5) galvanized steel wires (see fig. 6), galvanized trapezoidal steel wires (see fig. 7), galvanized tasellated wires drawn into special interlocking shapes (see fig. 8).

Steel armor wires are also used on cables intended for operation vertically, as in the case of mine shafts. In this case the tensile strength of the

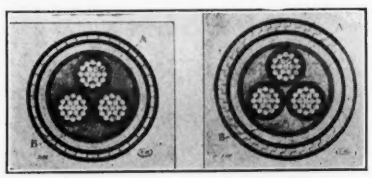

Fig. 7—Cross-section of three-phase cable armored with trapezoidal steel wires.
Fig. 8—Cross-section of three-phase cable armored with interlocking wires.

armor wires, is calculated to carry the weight of the entire length of cable, which is sometimes 800 to 1000 meters.

An armor consisting of a number of fine wires is sometimes used for the sake of flexibility in the case of cables which have to be wound and unwound a number of times as in the case of pumping and boring apparatus.

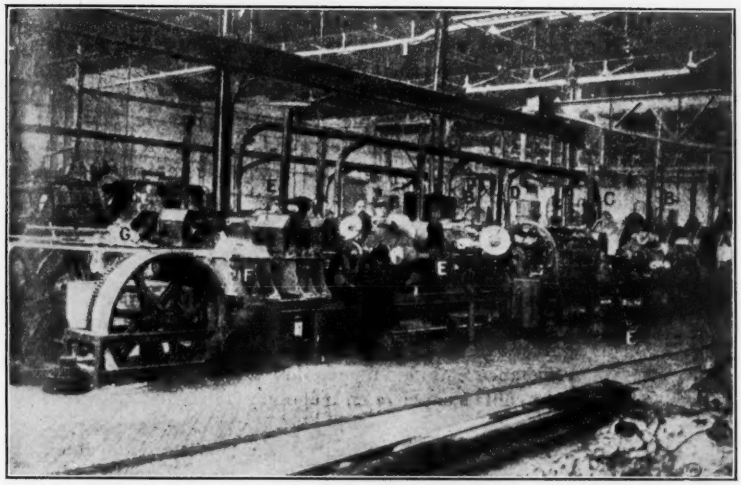

Fig. 9—Armoring machine for small cables. A, lead covered cable—B, jute head—D, steel taping heads—E, tar bath—F, heating bath—G, armored cable.

In the manufacture of the type of armored cable most frequently used, namely the steel taped cable all of the armoring operations are done at one time and on the same machine. These operations include:

(1) Protection against chemical reaction of the soil, and electrolysis. This protection is obtained by passing the cable through a bath of asphaltic compound, then the application of one or two paper tapes and finally passing the whole through another bath of asphaltic compound.

(2) The protecting cushion, which consists of a serving or layer of tightly applied jute and then passing the whole through a bath of tar or pitch.

(3) The armor proper, which consists in applying two steel-tapes as previously described, passing the cable through a bath of tar.

(4) The outer layer, which consists of a serving or layer of jute tightly applied and then passing first through a bath of asphalt and then through either a bath of whiting or chalk.

(5) Reeling.

In armoring with steel wires, a machine is used in which the steel taping heads are replaced by a stranding cage carrying either 36 or 48 or more, bobbins. Fig. 9 shows a combination machine which can apply either steel-tapes or steel wires, for armoring small cables.

When the armoring is composed of round steel wires or steel strands, the operation of the stranding unit is planetary, but in the case of trapezoidal or specially shaped interlocking wires, the bobbins are rigid and the wires are led through a perforated disc, the perforations being especially shaped and serving to guide the individual wires.

In the armoring machine, the baths of asphaltic and tar compounds, are heated by steam, the action of applying the various compounds, being independent of the operation of the machine the filling of the compound tanks being accomplished without stopping the machine itself.

In general, an armoring machine should be very substantially built and the capstan have a liberal capacity and size. Given the increasing diameters of cables carrying electrical energy, an armoring machine, must be able to armor cables with diameters up to 115 to 120 mm., which for formal manufacturing lengths, corresponds to a weight of 7 to 8 metric tons on reels having a diameter of 2.6 meters.

The Microscopic

Study of crystalline deworking—microstructural rate of reduction—uni-

By J. D.
Brunton's Research

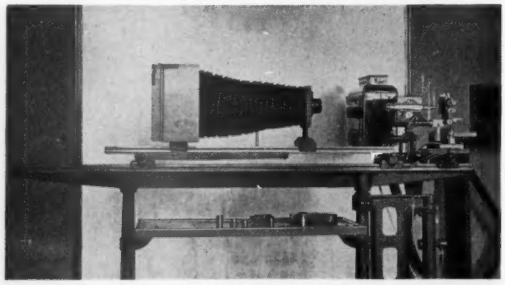

Fig. 3—Photomicrographic outfit.

UNDER this heading we have to deal with some of the chemical and physical changes that take place during the manufacture of wire and to offer, as far as possible, some explanation of their cause. It is also necessary to indicate how any of these changes, which may be deleterious to the product produced, may be counteracted. Of these changes some are due to the drawing process itself; some due to preliminary operations essential to wire-drawing; and others to operations—such as hot-galvanising—incidental to the main processes.

In the natural sequence of events effects are generally noticed long before their causes have been ascertained, but when cause and effect are connected by scientific study we are often able to group them together to explain the problems of practical work and in so doing it is frequently advisable to reverse the order of discovery and state the causes of a change first, in order that its effects will be more clearly understood. This at least appears almost essential in dealing with the effects of wiredrawing, because the modifications in the physical properties depend very largely on the condition of the material before drawing and especially on the microstructure. Chemical and microscopical analyses, however, cannot explain the entire mechanism of plastic flow in metals. This indeed will not be explained until the constitution of matter in the solid crystalline form is fully understood. A complete understanding of the flow of crystalline bodies involves a knowledge of the spacing of the atoms and the forces linking them together and more particularly how this is affected by externally applied forces. Any discussion of this purely theoretical aspect of the subject, however, belongs rather to the treatise on metallography than to a practical work of this nature and it will be well to confine ourselves here to a consideration of the effects of cold working as determined by observation and testing and to their causes, only so far as they can be discovered by chemical and microscopical analysis.

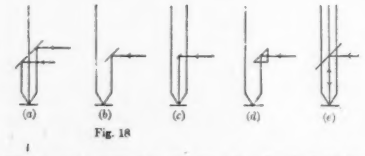

Fig. 18

Fig. 1—(a) Annular mirror. (b) Semi-circular mirror. (c) Central mirror. (d) totally reflecting mirror. (e) plain glass disk.

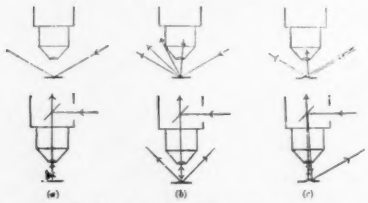

Fig. 2—Oblique and vertical illumination of (a) bright surface (b) dull surface (c) hills and valleys.

Chemical Changes:—

Not very many chemical changes take place in the process of wire manufacture. As far as the actual wiredrawing is concerned, it may seem that no such changes can take place but in the preliminary operations of preparing the metal for the drawing process slight chemical changes may occur which will have serious effect on the ultimate product and these can be prevented to some extent if the necessary care be taken.

Even in the actual cold working of steel, however, it would seem from experiments carried out by Whiteley and Hallimond that some chemical changes occur. These investigators found that the relative volumes of the gases given off when steel is attacked by Nitric Acid, that is Ammonia, Nitrogen and Nitric

Fig. 4—Setting the wire specimen in alloy.

Oxide, were completely altered by cold working. Full details of this investigation will be found in the Journal of Iron & Steel Institute Carnegie Scholarship Memoirs, Vol. IX. 1918 but since the results appear, so far as one can judge at present, of purely academic interest they need not be discussed here. They are mentioned, however, in order to illustrate the importance of scientific research in helping us to understand in full the effects of wiredrawing and the cold working of metals in general.

If a high carbon steel is put into a sulphuric acid bath for cleaning purposes and is left too long in an acid bath of this de-

Analysis of Wire

formations due to cold influence of annealing— formity of flow.

Brunton
Laboratory, Musselburgh, Scotland

scription, it will be found that slight decarburisation takes place on the skin of the metal. Sulphuric acid for cleaning is more expensive than hydrochloric acid but it is necessary to use this acid in many cases, more especially when a very bright surface is required. Care, therefore, must be taken not to keep high carbon steel in the acid trough too long; no hard and fast rule regarding the period of immersion can possibly be given, so this must be determined from practical experience. It may be taken, as a general rule, that the shorter the time the metal is in the acid bath the better, and mechanical facilitation of cleaning is to be recommended; that is, either scouring with sand or banging on a stone so as to loosen the scale and reduce the time in the bath. There is not the same danger in cleaning high carbon steel in hydrochloric acid and the above remarks do not apply to the same extent to steel cleaned by this acid, but in both acids the use of inhibiters which retard the attack of the steel is recommended.

A more serious cause of decarburisation on the skin of wire is faulty annealing. If a high carbon wire is annealed in a furnace with an oxidising atmosphere a certain amount of carbon is inevitably burnt out

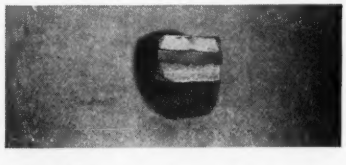

Fig. 5—Section of wire embedded in alloy.

of the steel; this causes what is known as "skin softness". Skin softness is, as a rule, obviated in either of the following two ways:

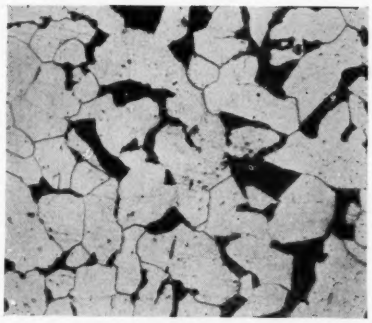

Fig. 6—Section of mild steel forging. Magn. 100 dia.

The material is taken out of the furnace when it is above the critical temperature and allowed to cool down in the air. This causes a thick scale of oxide of iron to gather on the material which is generally thick enough to take away all the decarburised surface of the metal. As will be readily seen, this would be a very expensive and wasteful method in thin gauges of wire, owing to the surface being very great in comparison to the actual weight of area of metal. The above method is, therefore, applicable only to bars and to the larger sizes of wire; moreover, unless the scaling process is carefully controlled further decarburisation may result.

The other method is to anneal the material in a nonoxidising atmosphere and allow it to cool down in a similar atmosphere, there being no free oxygen in the furnace to combine with the carbon in the steel and form carbon monoxide or dioxide and so rob the steel of a certain amount of carbon.

Another slight chemical change may take place in steel wire owing to the outer skin absorbing sulphur. Steel has a great affinity for sulphur; it is, therefore, important when annealing steel in an ordinary coal fired furnace to use a fuel which is as free from sulphur as possible. During the last few years gas has, to a great extent, superseded coal and most of the new wire annealing furnaces are gas fired. If the wire is being annealed in contact with a gas, and the latter has not been desulphurized, there is a tendency for the steel to pick up sulphur. The desulphurising of the gas is not a difficult matter and is an operation to be recommended. It can be accomplished by passing the gas through layers of oxide of iron.

One other change particularly associated with wire manufacture, which may be classed as chemical, is "graphitisation" or precipitation of free carbon. This sometimes occurs when high carbon wire is being annealed at a temperature round about 650°C. It appears that the previous cold working produces some change which facilitates the precipitation of graphite on annealing. It would seem, however, that this precipitation of graphite is associated with low temperature

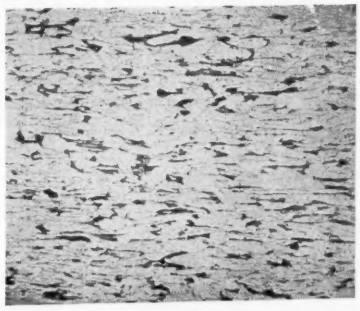

Fig. 7—Section of mild steel wire magnified 100 dia.

annealing only, because it does not occur in patented wire.

Physical Changes:

Much more important are the physical changes due to heat treatment and cold working and, although as explained above we cannot fully ascertain the causes of these from microscopic examination alone, careful study of the modifications in structure which occur helps us in a very practical way to understand what is happening and to get the results we desire in the

finished material.

The Microscopic Analysis of Wire

The Microscopic Analysis of metals thus finds important application in wire drawing. Excellent wire, of course, was drawn long before the microscope was used to examine metal structures, but the methods of manufacture were evolved only very slowly and improvements were the results of accidental discovery more often than not. This is particularly true in regard to the heat treatment of wire. The natural assumption is that metals should be made as soft as possible before being drawn into wire and, while this is true in general, it does not hold for all classes of wire. It was found about the year 1854 by James Horsfall that a very much harder and tougher wire could be produced from a rod which was not thoroughly softened in the usual way but only

Fig. 8—Same section as fig. 7 magnified 1500 dia.

semi-annealed, i. e., instead of allowing the rods to cool down very slowly as in ordinary annealing, they were cooled comparatively quickly in the air.

This process of heat treatment was called "patenting" and is the process now used in the manufacture of all high tensile steel wire. It is mentioned here because it affords a striking illustration of the use of the microscope. Although the process was discovered before metallography developed, it certainly was not understood why a semi-hardened rod could be drawn into wire more readily than a thoroughly annealed and completely softened rod. The microscopic, however, explains

Fig. 9—Longitudinal section 0.85% C steel wire drawn 2 passes. Magnified 550 dia.

this seeming anomaly clearly and so enables us to understand what is happening to the steel, and to explain many things relating to the production of wire in general which would otherwise be unintelligible.

In order to make this quite clear it is necessary to distinguish between the "ultimate composition" and the "proximate composition" of metals. The former is its composition as determined by chemical analysis, which tells us that steel contains, in addition to iron, so much carbon, manganese, silicon, etc., but does not tell us how these are built up. There is a somewhat striking analogy between metallography and medical science. A knowledge of the ultimate composition of the human body is of little use to the physician, because he is concerned with the proximate composition or the way in which the various constituents are built up. Thus he has to study anatomy, biology and pathology, and with the microscope we are able to study to a great extent the structure and composition of metals in a manner somewhat analogous.

For example, if we take a carbon steel and ignore for the present the silicon and manganese contents, the microscope tells us that the iron and carbon exist in the form of two primary constituents, viz, iron which in metallography we call "ferrite" and carbide of iron which we call "cementite". It has also told us that these two constituents can be linked up with one another in various degrees to form secondary constituents. The carbide can be completely dissolved in the iron when we have the single constituent "austenite", rarely found in straight carbon steels, at the atmospheric temperature; or it may be partly freed from solution in the iron, but separated in such finely divided particles as to be indistinguishable individually even at the highest power of the microscope, and yet in such a form as to alter the structure of the steel as a whole completely. This separation gives rise, according to the extent to which it has occurred, to two constituents, viz, "martensite" and "troostite". A third degree of separation is found in the constituent known as "sorbite" and here individual particles of the primary cementite can just be seen surrounded by the primary ferrite. Sorbite is not a definite constituent having always the same chemical composition and it merges gradually into the last constituent, "pearlite", which contains exactly 0.89 per cent carbon and consists of two primary constituents, "ferrite" and "cementite" in alternate lamallae. The final stage in this process of separation does not result in another secondary constituent but in a complete divorce of the two primary constituents, the cementite existing as globules surrounded by ferrite.

So much then for the anatomy of the steel. The biological aspect of the subject lies in the causes which lead to the formation of these constituents, i.

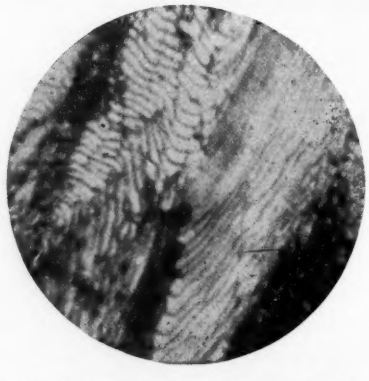

Fig. 10—Longitudinal section of wire too slowly cooled in patenting. Structure: sorbitic pearlite magnified 3000 dia.

e. largely in the thermal and mechanical treatment of the steel, while the analogy to pathology lies in the study of the defects due either to errors in treatment or to impurities in the steel.

Since metals are opaque to ordinary light they cannot be examined microscopically by means of transmitted light through thin sections, as are most specimens prepared for the microscope. The method adopted is to examine the prepared surface by reflected light. For this purpose the metal to be examined is sectioned either longitudinally or transversely as desired, made perfectly level with a file and ground with a series of emery papers, each succeeding paper being finer than the previous one until nothing but the very finest scratches remain. The final polishing is on velvet cloth covered with a polishing powder, such as rouge or diamantine, until all scratches are removed and a mirror-like surface is obtained. The structure of the steel is not revealed at this stage but the section is usually examined for non-metallic inclusions and other defects. For purely visual examination all that is necessary is a microscope fitted with a vertical illuminator, a bull's eye condenser and an incandescent gas burner or frosted electric bulb. The vertical illuminator consists of a small brass tube which can be screwed into position between the objective and the body tube of the microscope. At one side of the illuminator a small aperture permits the light to enter and fall on to a thin piece of plane glass set at an angle of 45 degrees, which causes some of the rays to be reflected at right angles through the objective on to the surface of the specimen, from which it is again reflected through the microscope to the eye-piece on which the image of the polished surface may be focussed. Sometimes a totally reflecting prism or a mirror is used instead of the plane glass illuminator, but these must occupy only half the area of the brass tube leaving the other half for the passage of the rays to the eye piece, and this, although it gives more brilliant illumination, tends to distort the image slightly, the effect of this distortion being serious at high magnifications. For this reason the plane glass illuminator is always to be preferred for the microscopic examination of wire specimens, where high magnification is essential.

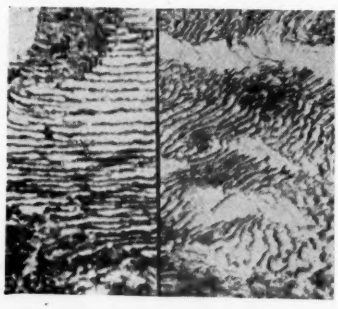

Fig. 11—0.50% carbon steel annealed. Magn. 1500 dia.
Fig. 12—Same steel drawn. Magn. 1500 dia.

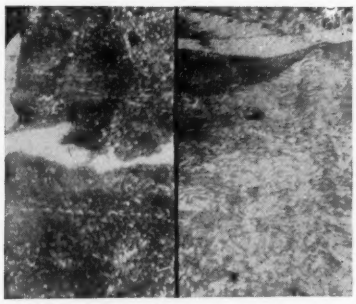

Fig. 13—Same steel as Fig. 11 patented. Magnified 1500 dia.
Fig. 14—Same steel patented and drawn. Magnified 1500 dia.

With low power objectives oblique illumination is occasionally used, where the light falls directly on to the specimen at an angle and is reflected according to the surface of the specimen. The various types of illumination and their effects are illustrated diagrammatically in figs. 1 and 2.

The full equipment required for photomicrographic work is ilustrated in figure (3). This consists of.

(1) The source of light—in this case an arc lamp.

(2) An optical bench, consisting of a lens to give parallel beams, a condenser fitted with a diaphragm and provision for colour filters and water cooling trough.

(3) A metallurgical microscope fitted with a vertical illuminator.

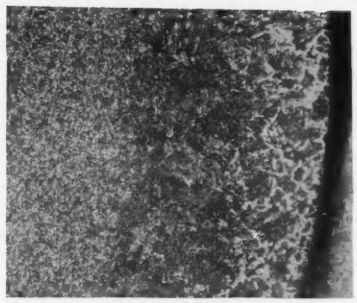

Fig. 15—Decarburised edge on 1.2 per cent carbon steel wire. Magnified 150 diameters.

(4) A camera without a lens for photographic work.

In preparing specimens of wire for the microscope, it is necessary to have a holder during cutting, filing and polishing operations. One method is to cut a section from a bar of mild steel or brass and to make a groove in this with a hack saw. The wire is then squeezed into this groove until it is firmly held. One objection to this method is that the surface of the wire is apt to be distorted by squeezing into the groove. a better method is to set the wire in an alloy of low melting point such as Wood's metal, or, which is better, one of the alloys described by Campion & Ferguson (ref.), the melting points of which are too low to affect the structure of the wire. For most wires solder also can be used but care must be taken to see that it does not reach a temperature above 300°C.

When the alloy has set round the wire a transverse or longitudinal section can then be made with the hack saw, followed by grinding or filing. The illustrations 4 and 5 show the wire with the alloy round it and the completed section ready for the microscope.

The final polishing of this section is carried out on a motor driven disc of wood covered with felt, chamois leather or velvet, impregnated with polishing powder continually moistened with water. The emery grinding may be done on a similar disc, but is preferably done by hand, the specimen being rubbed to and fro over the emery papers and turned through a right

(*Continued on page 434*)

Strong Steel Wire for Long Span Bridges

Review of the recent transaction of the American Society of Steel Treaters.

By L. D. Granger

Chief Metallurgist, Wickwire Spencer Steel Co.

ONE of the best and most largely attended meetings of the New York Branch of the American Society of Steel Treaters was held on the evening of November 14th. The main topic of discussion was "Strong Steel for Modern Long Span Bridges" which brought up as corollary subjects the use of Nickle Steel, Silicon Steel, and their heat treatments for bridge work, and also—of more interest to us—the application of wire to these structures.

Lack of Long Time Tests on Wire

A very interesting paper on requirements for bridge construction was read by Mr. Leon S. Moisseiff, under whose direction the new Hudson River Bridge is being built. Mr. Moisseiff reviewed the progress in selection of materials to meet the steadily increasing demands of bridge construction, due to increased spans, and the disproportionate increase of weight of materials as compared with loads carried. It is agreed that for the longest spans, wire cables are indicated, but, in the engineer's mind, the lack of long-time tests on heat treated wires, giving data as to the effect of aging, was a factor which has hindered the greatest advantage being taken of the tensile strengths now offered by the wire manufacturer.

Engineers Not Confident in Full Possibilities of Wire

One of the later speakers replied that repeated tests over a series of years showed that the only effect of aging was a slight increase in ultimate strength, the elongation and elastic limit remaining practically constant. It would be interesting to readers of WIRE if definite data on this subject could be furnished, and, undoubtedly, a greater confidence would thereby be engendered in the minds of engineers to whom the ultimate strengths attainable by proper wire drawing and heat treatments, by their very magnitudes, seem dangerous to utilize, even though the possibilities are interesting.

Mr. Moisseiff called attention to the fact that the ultimate strains specified for wire for bridge construction had increased from 160,000 lbs. per square inch in the Brooklyn Bridge to 215,000 lbs. for the new Hudson Bridge.

Research on Rivet-Steel Needed

Another feature which limits bridge construction is that of a proper rivet steel. There is a definite need for a new rivet steel which will be stronger than anything at present on the market, which will not scale on heating, and which will drive and head satisfactorily. Plate and girder construction, even though the higher quality silicon and nickel steels are used, are limited by conditions of riveting. It would seem that here is a promising field of research for the rivet manufacturer.

Mr. Moisseiff was followed by Dr. H. C. Boynton, Chief of the Research Division of the John A. Roebling's Sons Company, Trenton, N. J. Dr. Boynton described briefly the methods used in the Roebling plant for manufacturing Acid Open Hearth Steel for Suspension Cables. Roebling's adoption of Acid Steel dates back sixty years to the time when this process was the only known method of producing uniform grade of high carbon steel. Swedish pig and hand picked scrap were used, and the greatest care possible was used in melting,casting and rolling. The ruthless competition of other processes and insistent demands of consumers, however, forced the eventual use of selected brands of domestic pig, but the same care has always been maintained as to care in manufacture.

Acid Open Hearth Steel for Suspension Cables

According to Dr. Boynton, the superiority of Acid Open Hearth Steel is due to five factors,

1. The greater freedom from Sonims.
2. The greater freedom from occluded gases.
3. The fact that higher tensile strengths are obtainable from the same carbon in acid steel.
4. The greater uniformity as shown by chemical, physical, and microscopic tests.
5. The greater endurance to fatigue.

Dr. Boynton stated that a multitude of figures and data in his laboratory carried proof of all of the features mentioned above, and that the Roebling company would not consider the use of anything but Acid Open Hearth Steel where the safety of human lives was involved.

Basic Steel for Cables

The question of the superior quality of Acid over Basic Steel was attacked in opening by the next speaker, Mr. A. V. DeForest, Research Engineer of the Page Steel & Wire Company. Mr. DeForest is perhaps best known from his brilliant re-

searches into the magnetic properties of steel. He literally makes a piece of wire "write its own signature" which is as individual and unchanging as that of a human being. Mr. DeForest stated that his experience had shown through many years that little if any choice could be made between well made basic and acid steel, and that if the great superiority existed which was claimed, it was remarkable that so small a tonnage of acid steel was made.

Mr. DeForest's principal contention, however, was with that part of specifications for bridge wire calling for a galvanized finish. The process of galvanizing has a serious effect upon the physical properties of the wire, particularly as regards its bending elasticity.

Influence of Galvanizing on Physical Properties

Charts were shown of a wire originally testing 275,000 lbs. per square inch ultimate with a yield point (by the .7% elongation method) of 142,000 lbs. and an elongation of 1.5%, transformed into 228,000 lbs. ultimate, 150,000 lbs. yield and 4.5% elongation by hot galvanizing. This in general has been known to be the effect of galvanizing, and the engineer, seeing the higher yield point and greater elongation presumes a beneficial change. This, however, is not the case, as the resistance of the wire to bending has increased, and its elasticity in this direction greatly decreased. Mr. DeForest recommends the use of bright wire with some other method of rust proofing than galvanizing. This, too, is a fertile field for research and endeavor.

Torsion Tests

Another bete noir of the wire metallurgist was mentioned by Mr. DeForest, but, due to the unfortunately short time allotted him, could not be elaborated. This is the torsion test specified as a matter of rote by the engineer. For many years various kinds of wire—trolley, rope, and even common soft steels—have had included in the most elaborated specifications a requirement for torsion. The accepted idea seems to have been that a great number of torsions per inch was prima facie evidence of a superior quality in the wire. As a matter of fact, it is the opinion, well founded, of a great many wire metallurgists that the torsion test is of absolutely no value, and that its magnitude may vary widely without a corresponding difference in the quality of the metal. It seems to be more a reflection of the condition of the surface of the wire wherein minute striae, neglible as regards a tensile load, cause the torsions to vary. It is hoped that more light may be shed on this problem, and that some of the specifications which we are forced to meet may be modified.

Mr. H. T. Morris of the Bethlehem Steel Company gave an interesting account of mill practice in the manufacture of structural silicon steel sheets into plates for the Philadelphia-Camden bridge. On account of the affinity of silicon for a basic lining, care must be taken with the additions. As a result they are largely made in the ladle. Furnace additions are accompanied by additions of burnt lime to prevent washing.

More Articles

by

J. D. Brunton

of Bruntons Research Laboratory

will appear

in

forthcoming issues of

Wire & Wire Products

On account of various concomitant circumstances such as surface defects, severe specifications, captious inspectors, etc., the yield on these special steels is not much over 65% of the standard structural steels.

The other high strength steel in the field at present—nickel steel—was described by Mr. Clement E. Chase of Modjeski & Chase, Consulting Engineers of Philadelphia. The choice between Nickel, Silicon and ordinary steels is largely economic. For short spans where the relation between live and dead loads is not important, weight does not enter largely into the calculations; therefore a cheap steel may be used even though the strength is low. When spans increase, however, and the dead load must be kept low in proportion, it is possible to justify paying a premium for a steel with a greater performance. The choice is possible on a strictly mathematical basis, balancing increased cost per pound against decreased sectional areas.

The meeting was very successful and undoubtedly served to bring metallurgist and engineer into closer contact. To a wire man, several ideas were suggested—he was told, perhaps, that his product was in a way new and unproved, that, though he had made some improvements in physical characteristics, it was not certain that they would stand the test of time. On the other hand, the wire man suggested, at least, to the engineer, that his specifications were hidebound, and that a closer cooperation would result in advantages to both.

And to the wire men themselves, the questions in point—acid steel, galvanizing, torsion test, fatigue resistance, aging, —are of prime importance, and authentic data should be published for the use of the engineer, so that his skepticism may be overcome and his adoption of wire as a material for even the shorter bridges encouraged.

THE Gilby Wire Co. now of 123 Jackson St., Newark, N. J. has purchased the plant of the F. W. Dubors Co. in Riverside Ave. The property overlooks the Passaic River and has 30,000 sq. ft. of floor space. The manufacture of nickel chromium, nickel, monel metal and other alloys in the form of strip, sheet and wire will be continued.

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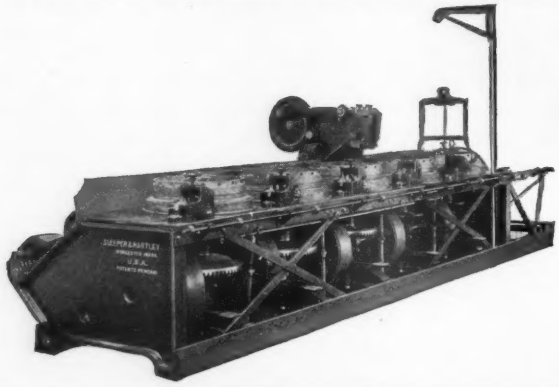

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3 to 4 Blocks to verag
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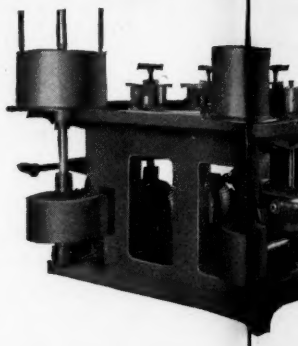

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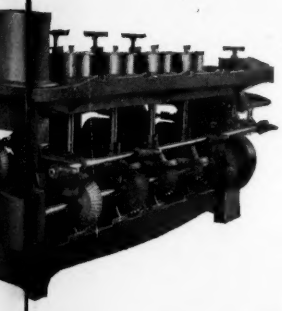

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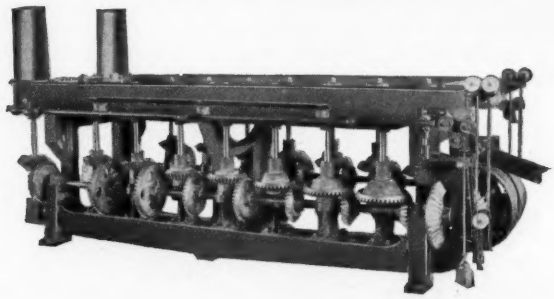
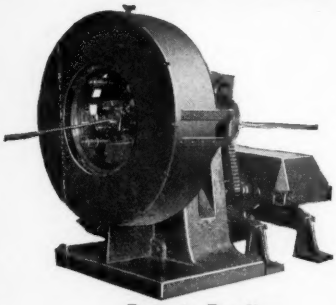
6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.

Many thousands of these heads in operation



ARMORING MACHINES FOR "BX," PARK CABLE MOTOR WIRES, HOSE Etc., Etc.



Patents Pending

High Productive Speeds

LOCK WASHER MACHINERY

with Enormous Output

HIGH SPEED STRANDING MACHINERY

...ARTLEY, Inc.

Agents: Philadelphia Territory
Swind Machinery Co.

ITALY—Henry Coe & Clerici, Milan. AUSTRALIA AND NEW ZEALAND—Edwin Wood Pty., Ltd., Melbourne.
JAPAN—Andrews & George Co., Tokyo. SWEDEN AND FINLAND—Akt., Rylander & Asplunds, Stockholm.

...RMASS., U. S. A.

"Personality" Advertising Helps Sell Wire

Some ideas back of the Driver-Harris series of "Superstition" Advertisements.*

By H. D. McKinney

General Sales Manager, Driver-Harris Co.

"THE facts and no frills" is by no means a poor motto for industrial advertising; but it seems to us to have its limitations. To explain what those limitations are, the simplest course seems to be to tell how, we believe, we are surmounting them in our own advertising; why we adopted a style which, to many people, probably seems to consist largely of "frills" and why it works in our case at least. Anyway, we know that it does work, and we think we know why.

The Driver-Harris Company has been manufacturing and selling a variety of special alloys for over thirty years; but the particular product that figures most largely in our present advertising story is "Nichrome" resistance wire for use in the heating elements of a wide variety of domestic and industrial electrical heating devices and apparatus. We believe our resistance wire is the best in the world from the point of view of uniform and high quality.

Progress Due To Research

We believe that our progressive position in our industry is due to the development and research work that is incorporated in our products. This can be summed up by saying that the "know how" of making these products is our stock in trade.

But is that all you need for a successful advertising program? Not in our opinion. And in order to see why not, consider for a moment the nature of our product, and the nature of our market.

In the first place, Nichrome is our trade-marked name for an alloy of nickel and chromium. There is no secret about our formula, or for that matter about the formulas of any of our principal competitors. The days of research and argument over such formulas have progressed to the point where, in an engineering sense, pretty nearly everything is known about them. The necessary properties, requirements, characteristics, specifications or whatever you choose to call them, for heating elements of any kind or description, are matters of common knowledge on the part of any competent electrical engineer—or at least are where he can readily find them, in reference books in which he has confidence.

The chances of finding out anything startling new and important about resistance wire, from the standpoint either of material or of design, after all the study and experiment to which the whole field has been subjected, can hardly be called exceptionally good. For that very reason, the chances of finding anything very new to say about your resistance wire, which anybody else cannot or will not say about his, from either of those same standpoints of material or design, are equally poor.

Product Well Known

In the second place, our market consists of people who know every word of our story, and every word of our competitors' stories, at least as well as we do. They have been hearing it—all of it—for years. They have been buying resistance wire for all those years, you might say by the carload. They are just about the hardest people to fool the world can produce, even in buying something newer to them than resistance wire; people who know exactly how to wave aside any clever but superficial "talking point" and get down to the essential facts.

They know what they want and they know also that their own standing, in their industry, depends upon their getting exactly what they require.

Further they know that the heart and future of the heating device depends upon the element and since the heating element in a device selling for several dollars costs only a few cents, the buyer of our products must of necessity, be uncompromisingly particular.

What can advertising do for you in a situation like that? As I see it, it can do a great deal. The very fact that you have to face the keenest and most merciless kind of competition, that goes right down to the naked bedrock of quality and price, makes it all the more essential that you overlook no efficient means of increasing the effectiveness of your sales effort.

The manufacturer of a staple or a near staple can no more afford to carry one ounce of fat on his selling muscles than on his producing muscles. He must make every minute of his salesmen's time count. Here, in our view of it, is where advertising comes in. In selling an engineering staple to a fact-sated audience, it can give the salesman a running start, instead of a standing start or a handicap, in his effort to get on those terms of friendliness, mutual respect and confidence which must precede a sale.

"Institutional" With A Difference

To try to sell our wire just as resistance wire, would merely put us on all-fours with every other resistance wire manufacturer. When you come right down to it, what is there for us to say about our product, except to ring the changes on the bare assertion that it is a good product? And if every one of your competitors can, and frequently does, say exactly the same thing or much more than we are will-

*Reprinted from Printers' Ink.

ing to say, how is the buyer to distinguish among you? Of course it may not be equally, or so uniformly, true when the other fellow says it—it is of course an article of faith with you that it is not—but how is the customer to know that?

But when you set out, in your advertising, to sell "Nichrome" as the product of the Driver-Harris Company, you bring in the element of individuality and the pride of the manufacturer in his product, which just plain nickel-chromium resistance wire, by itself, lacks. And in so doing you take the first step in that running start for the salesman.

But right away you need a very different kind of advertising from that of conventional claims for the excellence of Nichrome.

Your aim is to establish your company in the buyer's mind as an institution with a distinct personality, a character and an integrity of its own which form a safeguard which is of value to him—something definite for him to take hold of and to rely upon.

Quaint Advertisements

The very unlikeness of the advertising that can do this, to the conventional advertising which surrounds it in the pages of the industrial journals where it meets the buyer's eye, is in itself a great initial advantage. It is bound to be read by more people than will read any merely conventional advertisement. And reading it, they give it a chance to set its suggestion of a distinct company personality to work in their minds.

But you can't go too far afield. Mere quaintness or queerness for its own sake is no better than conventionality — perhaps worse. If it seems to the reader to have no reason for existence except the desire to be quaint and queer, if it attracts attention and then has no point to which to direct that attention after it has been attracted,

(*Continued on page 432*)

NEWS OF THE INDUSTRY

Origin of British Wire Imports To Be Marked

IMPORTED iron and steel wire, wire nails and staples have been under consideration by the Standing Committee appointed under the British Merchandise Marks Act of 1926, for a considerable time. The committee has now issued its report, in which it recommends that these articles should bear the indication of origin at the time of sale or exposure for sale in the United Kingdom.

The articles classified for marking are: barbed wire on reels, wire nails and wire staples, wire in coils or bundles, including strand wire, and baling wire cut and looped at one end or both. The recommendations do not apply to wire nails and wire staples when sold or exposed for sale in quantities of 14 pounds or less, or in packages in which they are imported.

The committee recommends that the Order in Council enforcing the recommendations should become effective three months after the making of such an order.

Modern Wire Rope Works In Australia

THE Australian Bureau of Steel Manufacturers held its annual meeting at Newcastle, New South Wales, recently, and members then took the opportunity of inspecting the various steel-producing and manufacturing works for which the city is famous.

One of the latter undertakings which produced a notable impression on the visitors was the plant of the Australian Wire Rope Works, Ltd., which has been established by the joint efforts of well-known leading wire rope manufacturers in Great Britain, in association with the Broken Hill Proprietary Co. The machinery is of the latest and most efficient type, having been selected by experts on the staffs of the promoting companies. Active production began nearly three years ago, and this important industry is now firmly established in Australia.

The plant has a capacity covering all general Australian requirements, and ropes are turned out varying in size from ¼-inch to 7 inches in circumference. Special provision has been made for the manufacture of wire rope for mining purposes, and it is claimed that the product is equal to the best imported from abroad.

After their tour of inspection the visitors sent the management a letter expressing their appreciation of the great efficiency of the undertaking.

THE new billet and rod mill of the American Steel & Wire Co., Worcester, Mass. built at a cost of $2,000,000 is in operation. It has a capacity of 4200 feet a minute.

A GROUP of Springfield manufacturers and bankers have closed a deal taking over the Cheney D. Bigelow Wire Works of Springfield, Mass. The company was started in 1842. The president of the new corporation is W. Bruce Pirnie.

THERE has been a consolidation of the Hazard Wire Rope Co., Wilkes Barre, Pa. and the Waterbury Co., Brooklyn, N. Y. mfg. of wire rope, cordage, etc. The production of wire rope, cable, etc. will be continued at the Wilkes-Barre plant exclusively and machinery from the Brooklyn plant will be moved there. The Brooklyn plant will continue its manufacture of cordage.

INCREASED production facilities at its new location on Cloverdale Ave. has been the reason for the removal of the Acme Wire & Iron Works, Detroit, from its plant at Canfield Ave.

Longest Span Cableways For Nile Project

FURTHER details of the great cableways for the Nag Hammadi Barrage have now been received direct from John M. Henderson Co., Ltd., Aberdeen, the designers and manufacturers. The barrage is being constructed across the Nile by Sir John Jackson, Ltd., and the five aerial cableways are to be used for the transport of materials and men during the actual building operations. They will be the longest span cableways that have yet been constructed, each being 3,100 feet between the masts. The steel masts 182 feet in height are being so arranged that they may be luffed or swayed sideways so that the main cable of each unit may be moved a distance of 25 feet on each side of its center line to allow the plant to cover the required areas. The load with which each cableway can deal will be five long tons (5 3-5 tons) at a hoisting speed of 250 feet per minute, and a traveling speed of 1,250 feet per minute. The total length of steel wire rope required for the plant amounts to no less than 22½ miles.

The equipment is operated by electrically - driven winding gears, the operating platforms being carried on towers about 40 feet in height to enable the drivers to obtain a better view of operations. On each driver's platform there is to be provided a mechanically-operated indicator gear which will show the operator the position of the load at any time.

The longest span-cable at present in operation is one of 2,060 feet span for the Bradford Waterworks, which will be exceeded in the case of the Nag Hammadi installation by over 1,000 feet. Three of the five equipments have already been shipped to Egypt. Messrs. Henderson are also responsible for the Bradford installation.

Domestic Exports of Iron and Steel Wire, Wire Rope and Nails, From the United States, By Countries

September, 1927

Countries	Plain iron or steel wire	Galvanized wire	Barbed wire	Wire rope	Insulated iron or steel wire and cable	Wire nails
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Belgium	1,100	1,520	.....	.....	.....	.....
Finland	6,634	.....	.....	1,750	.....	.....
France	.....	.....	.....	122	.....	.....
Greece	.....	.....	.....	.....	9,850	.....
Irish Free State	22,300	44,800	67,200	.....	.....	71,008
Netherlands	.....	.....	.....	.....	.....	133
Norway	4,200	.....	.....	2,360	275	.....
Sweden	101	.....	.....	2,620	.....	.....
United Kingdom	159,983	10,276	67,734	.....	.....	48,107
Canada	542,127	765,619	766,704	108,609	34,106	14,444
Brit. Honduras	.....	.....	.....	.....	.....	300
Costa Rica	3,250	1,000	83,900	9,580	.....	2,640
Guatemala	302	260	72,100	965	.....	3,642
Honduras	1,087	1,660	349,125	411	2,930	58,385
Nicaragua	1,744	500	163,350	317	.....	85,070
Panama	581	3,708	26,758	21,909	612	43,656
Salvador	.....	.....	.....	.....	1,335	2,150
Mexico	2,031,079	572,416	654,357	68,624	14,718	18,280
Miquelon & St. Pierre	.....	.....	.....	672	.....	2,300
Newfld. & Labr.	400	.....	.....	.....	.....	.....
Bermuda	.....	.....	.....	.....	.....	800
Jamaica	.....	740	.....	.....	2,699	300
Trinidad & Tobago	.....	1,150	.....	.....	.....	5,000
Other Br. West. In.	.....	5,176	6,000	849	.....	10,080
Cuba	148,892	122,476	1,109,789	46,909	13,433	143,451
Dom. Republic	19,283	4,095	188,675	4,199	607	76,645
Netherland W. In.	.....	.....	3,626	.....	.....	730
Haitian Republic	3,638	.....	21,500	231	.....	38,300
Virgin Is. of U. S.	.....	2,090	.....	.....	.....	3,200
Argentina	638,057	2,468,990	1,590,350	82,425	.....	1,767
Bolivia	.....	.....	.....	5,410	.....	145
Chile	77,403	17,100	1,707,238	17,047	5,344	.....
Colombia	1,000	251	.....	25,717	5,942	544
Colombia	96,667	20,975	847,346	30,894	10,122	190,671
Falkland Islands	90	5,150	46,750	.....	.....	.....
British Guiana	.....	.....	3,000	.....	.....	.....
Surinam	.....	251	.....	.....	.....	.....
Paraguay	.....	.....	22,046	.....	.....	.....
Peru	.....	.....	3,000	17,500	200	4,140
Uruguay	82,773	127,867	70,548	402	13,119	.....
Venezuela	223	4,883	187,585	11,847	10,086	23,238
British India	100	88,972	85,027	9,831	.....	.....
British Malaya	.....	.....	120,000	.....	.....	200
China	78,410	56,000	.....	697	.....	.....
Other Netherland East Indies	.....	.....	55,639	114,689	.....	.....
Japan, inc. Chosen	13,540	45,386	.....	.....	.....	137,667
Philippine Is.	280	145,794	1,277,688	140,496	.....	1,479,460
Australia	212,885	312,330	79,520	.....	.....	1,165
British Oceania	.....	.....	2,379	362	.....	.....
French Oceania	.....	100	.....	.....	.....	.....
New Zealand	2,434	.....	.....	730	.....	1,100
Br. South Afr.	1,777	.....	292,500	6,087	1,139	101
Liberia	.....	.....	1,120	.....	.....	.....
Total Quantities	**152,340**	**4,831,535**	**9,972,554**	**734,261**	**127,517**	**2,468,823**
Total Values	**146,259**	**125,606**	**282,284**	**98,196**	**14,801**	**75,102**

Shipments from the United States to Non-Contiguous Territories.

	6083 Wire		6092 Wire Nails	
	Pounds	Dollars	Pounds	Dollars
Alaska	91,486	7,918	126,603	5,943
Hawaii	368,386	30,469	545,749	25,942
Porto Rico	447,504	21,154	184,610	6,389

THE Phoenix Wire Works, Detroit, manufacturers of wire cloth and screening as well as wire and iron work has been incorporated under Michigan laws.

The Wickwire Spencer Steel Corp. was placed in the hands of receivers, under an order issued by the U. S. District Court of Buffalo. Liabilities of $22,000,000 as against declaration of $29,000,000 assets are the figures filed in the application.

THE Arrow Screen Co., Mfg. of screens and wire specialties is erecting a new one story building as an addition to its plant.

Domestic Exports of Iron and Steel Wire Manufactures, Horseshoe Nails and Horseshoes From the United States, By Countries

September, 1927

Countries	Woven wire fencing	Wire cloth & screening		Wire n. e. s. & manufactures of	Horseshoe nails	Horseshoes
	Pounds	Pounds	Dollars	Pounds	Pounds	Pounds
Belgium	1,398	.....	.....	67	2,310	.....
Czechoslovakia	.....	.....	.....	400	.....	.....
Denmark & Faroe Is.	.....	.....	.....	628	.....	.....
Finland	.....	.....	.....	461	.....	.....
Germany	.....	.....	.....	1,387	.....	.....
Netherlands	.....	360	175	.....	4,551	.....
Norway	.....	.....	.....	2,996	.....	.....
Portugal	.....	.....	.....	130	.....	.....
Spain	.....	.....	.....	30,035	.....	.....
Sweden	.....	.....	.....	433	.....	.....
Switzerland	.....	.....	.....	1,500	.....	.....
United Kingdom	105,206	.....	.....	204,260	3,000	.....
Canada	61,003	202,302	15,141	615,601	31	30,259
Brit. Honduras	1,200	134	24	2,259	25	100
Costa Rica	7,738	801	90	3,112	700	7,200
Guatemala	408	.....	.....	3,701	200	.....
Honduras	3,677	2,464	418	751	.....	400
Nicaragua	240	15,464	821	1,014	.....	400
Panama	5,587	5,199	484	8,291	1,400	4,000
Salvador	45	.....	.....	1,910	800	.....
Mexico	19,093	11,068	1,907	205,857	21,280	19,733
Newfld. & Labr.	.....	.....	.....	729	.....	.....
Bermuda	.....	150	34	967	.....	800
Barbados	.....	180	30	1,850	.....	400
Jamaica	4,380	1,348	114	672	.....	.....
Trinidad & Tobago	207	.....	.....	562	.....	.....
Other Br. West In.	1,642	426	38	.....	.....	100
Cuba	142,157	21,051	3,348	61,277	20,600	40,125
Dom. Republic	11,016	4,677	638	6,672	100	.....
Netherland W. In.	21,316	332	52	3,199	.....	.....
Haitian Republic	13,695	.....	.....	21,125	100	.....
Virgin Is. of U. S.	.....	.....	.....	510	312	100
Argentina	147,922	9,068	1,650	139,511	.....	.....
Bolivia	.....	5,993	992	2,358	.....	.....
Brazil	.....	1,317	171	5,962	.....	.....
Chile	1,659	26,190	2,878	10,506	3,520	800
France	.....	.....	.....	10,666	.....	.....
Colombia	10,649	12,168	2,172	24,719	11,325	.....
Ecuador	.....	2,033	391	7,308	.....	.....
British Guiana	2,157	.....	.....	.....	.....	.....
Peru	.....	449	196	14,307	1,300	.....
Uruguay	.....	4,604	706	1,311	.....	.....
Venezuela	592	5,876	1,100	1,852	2,200	.....
British India	68,126	.....	.....	165,263	.....	.....
British Malaya	31,023	1,960	323	2,312	.....	.....
China	.....	280	269	6,870	.....	.....
Java & Madura	.....	1,625	538	207	.....	.....
French Indo-China	.....	.....	.....	2,410	.....	.....
Hongkong	.....	.....	.....	979	.....	.....
Japan, inc. Chosen	1,560	270	125	74,125	35,500	.....
Kwangtung	.....	1,620	388	.....	.....	.....
Philippine Is.	30,886	26,201	3,244	5,909	36,000	.....
Siam	.....	67	15	.....	.....	.....
Australia	.....	34,653	5,806	163,975	7,150	.....
British Oceania	.....	45	21	417	.....	.....
New Zealand	135	342	71	5,071	.....	.....
Brit. South Afr.	998	13,327	3,070	4,113	500	.....
Egypt	.....	.....	.....	2,090	.....	.....
Other French Afr.	.....	.....	.....	46	.....	.....
Mozambique	.....	470	82	2,665	.....	.....
Total Quantities	**695,715**	**414,514**	.....	**1,837,308**	**152,904**	**104,417**
Total Values	**30,962**	.....	**47,522**	**147,231**	**15,470**	**7,560**

Galveston Will Have Nail Plant

The new $500,000 plant of the Texas Nail and Wire Manufacturing Company, which covers two blocks of ground behind piers 16 and 18, is expected to be completed late in January, according to announcement made by officials. Application for a charter which has been made to Austin declares the company will manufacture wire and wire products. It will be capitalized at half a million dollars.

The plant will produce galvanized and barbed wire, nails, staples and eventually netting and poultry wire. It is believed the plant will employ about 150 men at the start of operations.

The incorporators are K. Tidemann, Bartlett D. Moore, Charles S. Peek, George Sealy and Harry G. Black.

Tidemann said all the capital stock had been paid in and that the majority of the stockholders are Galveston citizens. He said the factory would run on a 10 hour basis during the first year of operation and that it expected to produce about 30,000 tons of wire and nails during that time. It was announced that the greater part of the output would be sold in the gulf coast country.

This is the first plant of this character to be located in the Southwest.

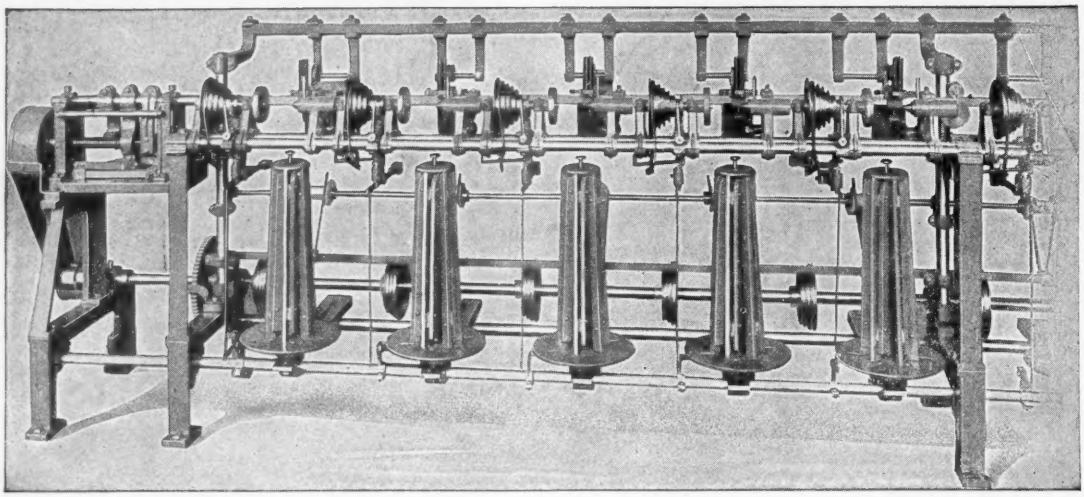
J. H. Murray, who has been named mill superintendent, is at present here overseeing the work of installing the machinery. S. A. Johnson is acting as designing engineer while C. S. Porter is in charge of the erection of the buildings.

The portion of the plant of the Stamford Rolling Mills, Inc., Springdale, Conn., that was destroyed by fire is now under reconstruction. The cost will be about $75,000.

The Richmond, Ind., plant of the Belden plant of the Belden Mfg. Co. has plans under way for an addition to cost in excess of $50,000.

OAKITE Service Men held their Annual Conference on industrial cleaning in New York, November 7 to 10, to discuss cleaning and related problems.

At this year's conference 16 different technical papers were presented covering a wide range of subjects, among them being "Some Newer Oakite Methods and Equipment for Railroads," "Developments in Cleaning Operations for the Oil Industry," "Handling Metal Cleaning and Rust Prevention Problems," "Cleaning Methods for the Baking Industry," "Oakite Materials and Methods in Meat Packing Plants," "Oakite in the Dyehouse," "Oakite Materials in Automobile Service Stations," "Electroplating and Cleaning Methods," "Oakite in Hotels and Institutions," and others. Other papers deal with various cleaning and washing operations in dairies, bottling plants, laundries, hospitals, printing electrotyping and lithographing plants.



KOEGEL FINE WIRE SPOOLING MACHINE FOR SPOOLS UP TO 6" DIAMETER, STANDARD MACHINE FROM FOUR TO TWELVE HEADS. CAN FURNISH WITH ANY DESIRED NUMBER OF HEADS.

Above illustration shows our improved type of fine wire spooling machine. This machine has some very important features, for example, the head sections are so designed that no spool spindles are required, and this, we believe, is a very good time saver which all manufacturers will appreciate. Another feature is that the swifts or blades are located underneath the machine, and directly in front of the operator, thereby making it very convenient for the operator when filling the swifts or blades with bundles of wire. Write us for further details about this machine.

Wire Spooling and Winding Machines of Every Description

CHAS. KOEGEL'S SONS, INC.

Holyoke, Mass.

THE National Harris Wire Co. of Newark, N. J. has taken a long term lease on the Verona Ave. plant of the Heller Bros. File Co. and plans to move both its rod mill and wire mill to that plant. Executive offices will remain at 113 Orchard St.

THE Upson-Walton Co., Cleveland, has filed plans for a new one-story plant. This company manufactures wire rope, cables, etc.

THE Acme Wire & Iron Works, Inc. of San Antonio, Texas is building a one story addition to its plant at 1601 N. Lared St.

Personality Advertisement

(*Continued from page 429*)

it will do more harm than good. You have to remember that you are, after all, in business to sell Nichrome, and that your readers are in business, among other things to buy it.

What do we do? We start from a point about as remote from our real business as could well be imagined—and half the fun, for ourselves and for our readers, is in finding out by what verbal acrobatics we can, in less than a hundred words, leap the interval and wind up talking about the real point of the whole advertisement.

We can claim no particular originality in the general idea of our present advertising. George M. Cohan, in "It Pays to Advertise," long ago pointed out that everybody is superstitious, or at least interested in superstitions. All we did was to apply the familiar superstitions—or, as we are careful to point out, "the other fellow's superstitions,"—to the business of buying resistance wire.

I don't believe the man exists who, seeing a certain cartoon illustrating a familiar, or even an unfamiliar, superstition, will not stop to see what it is all about. Even if he quits the moment he sees the point or sees our name, he has seen it for all that, and some impression has been produced on him.

He may not realize it, but he passes on to the next advertise-

ment with at least the germ of a notion implanted in his head that Nichrome is especially good resistance wire, and the Driver-Harris Company a good manufacturer, even if it does have original, and in his view undignified, ideas about advertising.

What more can you ask? Could we accomplish even one-tenth as much as that with a long and painstaking discussion of the specifications for good resistance wire and an explanation of the exactitude with which Nichrome meets those specifications? Where is the point in telling people things they know already to the point of boredom and beyond?

All they need is to be reminded of those things and the business of reminding them can surely be accomplished at least equally well by starting with something that interests, and even amuses them a little.

Please remember that we are not theorizing about this. We know. We have been at this kind of advertising long enough for the results to become evident. When we get hundreds of letters every year from our best customers asking us to be sure not to forget them when we send out our calendar embodying the current series of "The Other Fellow's Superstitions" in permanent form—when many of these letters suggest new superstitions which the writers think sufficiently quaint or amusing to be included in the series (as many of them are)—we are not apt to worry about the results or about the effect upon our own dignity.

This is particularly true when many of these customers who write to us have become customers only since we commenced this kind of advertising. Perhaps it is a logical fallacy to say: This event came, in time, after this event, therefore there must be a causal relation between them. But perhaps it isn't. We incline to the latter opinion in our own case at least.

We know too many serious-minded electrical engineers and

URDIKA

ELMARID

The most improved metal composition die.

Manufactured in sizes ranging from .020" to .300"

STEEL SET

DIAMOND DIES

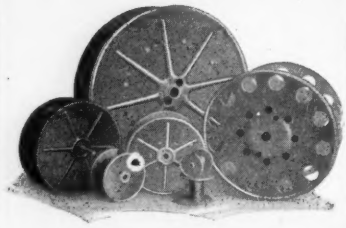
Highest Quality

Accurate Size Smooth Draw

URDIKA

WIRE DIE WORKS

105-107 Fulton Street New York City



Modern Steel Equipment For Handling Wire

Spools and reels of finest steel effect substantial savings in the handling of wire during manufacture and shipping.

Mossberg experts, the originators of steel reels and bobbins for wire manufacture, can show you the way to modernize your equipment and realize considerable economies thereby.

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Microscopical Analysis of Wire

(*Continued from page 423*)

angle at each change of paper, so that the scratches from the coarser paper may be most easily removed by the finer.

Etching

Assuming now that the section has been polished and examined for slag, dirt etc. in the steel and that we wish to study its structure, it is necessary to etch the steel. Many different solutions have been used but for wires it is usual to employ an alcoholic solution of either nitric or picric acid. For mild steels a 10% solution of nitric acid in alcohol is most useful and for the higher carbon steels a mixture of 5% nitric and 5% picric acids in alcohol will be found suitable, especially for patented steel wires. The section is dipped in the etching solution for a few seconds and then washed throroughly in running water. It is then finally washed in alcohol or in hot water and either wiped dry with a silk cloth or cotton wool, or, if picric acid has been used, allowed to dry by evaporation.

The etching solutions attack one constituent more than another so that they reflect light differently and are thus distinguished under the microscope. Metal sections are very easily mounted for the microscope. They are simply placed face downwards on a clean glass slide and covered with a brass ring. Another glass slide with a small piece of plasticene on it, is then pressed on to the back of the specimen until complete contact is made with the brass ring, as shown in the sketch below. In this way the section is quickly mounted in such a manner that the surface to be examined is perfectly level.

The Structure of Wire

Before considering the structure of wire it is first necessary to describe briefly the structure of metals in general. When a pure metal freezes crystals belonging to the Cubic system form, these tend to build up in groups and, if allowed perfect freedom to grow, will form in a fern or three-like cluster somewhat like frost on a window pane or the spangles on a new galvanised iron pail. In a steel ingot, however, the growth of the crystal is restricted to some extent by the neighbouring groups and by the sides of the mould so that we do not get such perfect forms. The general macro structure of an ingot or other steel casting is, nevertheless, roughly fernlike and this structure is known as dendritic or ingotic. When an ingot is hot-rolled, or forged the structure is more or less broken up and, although the crystals tend to grow again when rolling ceases, the temperature of the metal is too low and the time allowed is too short to permit of the formation of true geometrical figures. The result, therefore, is an aggregate of fairly small crystals or crystalline

grains in the form of roughly shaped polygons with rounded edges. This then is the typical structure of all pure metals after forging or rolling.

One of the most important points in the structure of a metal is the size and number of these crystalline grains and this is determined mainly by hot-rolling and heat-treatment, but it also depends very largely on the mass of the piece of metal as a whole. Thus under normal circumstances the crystals in a thin piece of wire will be much smaller than those in a billet or thick bar, as may be seen from figs. (6) and (7).

As a rule the larger these grains and the fewer their number in a given area, the weaker is the material, the strength of a single crystal being less than that of a fine crystalline aggregate. At the same time it has been proved that, the larger and fewer the crystals, the more ductile is the material, a point of considerable importance in relation to wire drawing. The size of the crystals in wire is also of importance in relation to the microscopic analysis, because it involves the use of higher magnification than usual. This will be evident from figs. (7) and (8) which show the same section of mild steel wire at low and high powers. The necessity for high magnification is even more clearly seen in studying the structures of patented steel wire because here we are dealing not only with fine grains, but with the still more finely divided constituent sorbite.

It is now possible to describe what the microscopic analysis of wire can tell us and to illustrate one or two of the more important points. The information it can give us about the steel in general—such as the presence of slag, sulphide of manganese, aluminium oxide and other non-metallic inclusions, the presence of laps and seams on the surface and various other defects—forms too big a subject and, since it is not peculiar to wire, need not be discussed here. For information of this nature the

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GREASE or oil on the wire may be responsible. For such coatings, unless *thoroughly* removed before pickling, cause pollution of the acid. Excessive consumption is the result.

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reader must be referred to text books on metallography. The microscope, however, can give us valuable information which is peculiar to wire and it is this particularly which we wish to illustrate.

Dealing in the first place with mild steel or some of the non-ferrous metals which have a similar structure, it can tell us how the crystals are deformed by cold working such as wire drawing, how they are affected by annealing and at what temperature annealing should be carried out in particular cases. It can also tell us approximately how far a wire has been drawn since the last annealing and even, to some extent, how the wire has been reduced, i. e. whether in light or in heavy draughts, although this is very difficult even to the most experienced observer. It can also tell us one very important thing in connection with wire drawing, viz, whether the flow of the steel has been uniform or not.

Uniform flow is one of the most important things in wire drawing. Apart from the well known irregularity in flow, which results in "cuppy" wire and which can readily be detected without the microscope, there are other types of irregular flow which are not so obvious and one in particular which only the microscope can reveal. This may best be described as "wavy" flow and it is due in general to dirty steel. It is not very easy to demonstrate this fault by photomicrographs because its effect on the structure is very slight except in extreme cases and can be seen, as a rule, only by expert visual examination. It is a fault which is indeed present to some extent in all wire; the only wire which approaches perfect regularity of structure is the finest piano wire, and with some experience it is often possible to grade the wire by extent of the waviness in the structure or fibre.

Turning now to the structure of patented steel wire, we have here what is probably the most striking illustration of the ap-

plication of metallography to wire drawing. At the beginning of this article we referred to the discovery of the patenting process and stated that only the microscope could supply a rational explanation of the apparent anomaly of semi-hardened steel being more suitable for wire drawing than thoroughly annealed steel. We also described briefly with illustrations the various constituents of steel. Now consider a series of three steels in the form of wire rods:

(1) A mild steel or ingot iron containing not more than 0.05% C.

(2) A medium steel containing about 0.45% C.

(3) A steel containing about 0.90% C.

and anneal them by heating to a temperature of about 800/850° C. and cooling slowly so as to make them as soft as possible, their structures will consist of the two constituents, ferrite and pearlite, in approximately the following proportions:

1. Ferrite 100%; pearlite nil.
2. Ferrite 50%; pearlite 50%.
3. Ferrite nil; pearlite 100%.

If we now try to draw these steels into wire and reduce them as far as possible we shall find that number (1) will draw easily and can be reduced in size considerably without re-annealing. Number (2) will also draw fairly easily but not so far as number (1), while number (3) will be difficult to draw more than about two passes. Thus, when the steels are in the thoroughly annealed condition, the higher the carbon content the greater is the difficulty in drawing. If, however, the rods are patented instead of annealed the structure of the mild steel will be unaltered, but the second will consist of about 90% sorbite and 10% ferrite, while the third will be entirely sorbitic. In this condition the steel containing 0.90% carbon will draw almost as well as the mild steel and the steel containing 0.45% carbon will draw equally well and even more uniformly.

Let us now see why this is so. In fig. (9) we have a longi-

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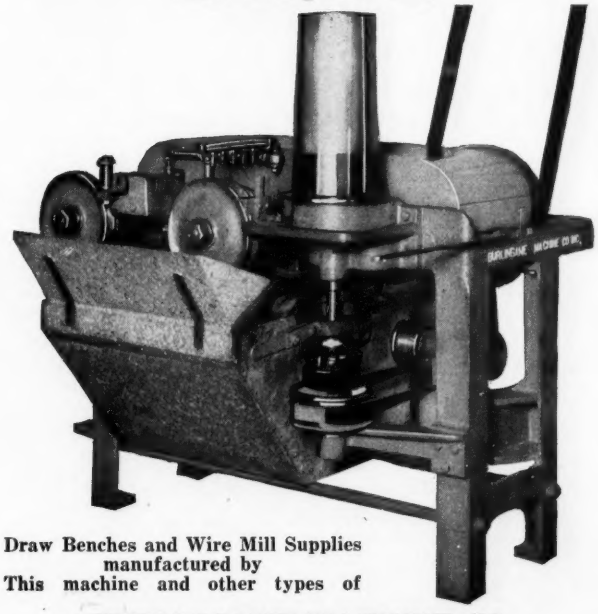

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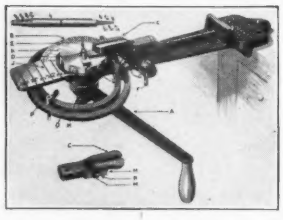

Patented April 2, 1918
M. D. Kilmer & Co. Cleveland, Ohio, U. S. A. Box 237, Station B.

tudinal section of a wire containing about 0.85% carbon which has been annealed and drawn two passes. Several attempts were made to draw this wire further without success. If we look closely at this section it will be seen that in one grain the laminations of the pearlite lie at right angles to the direction of flow, while in a neighbouring grain they lie approximately at an angle of 45 degrees. Now imagine two packs of cards arranged in this way and apply a force in a direction parallel to the longitudinal axis of the wire. The first pack of cards could be caused to move in the required direction by bending, but the cards in the second pack would easily slide over one another and move partly in the direction required. Now imagine several packs of cards arranged at many different angles to the line of flow. It will be obvious that when a force is applied some will slip easily, others with difficulty and some not at all. Similarly, with an aggregate of pearlite grains the flow, which can take place only by slipping along the natural gliding planes, i. e. along the laminations, will be very irregular and before long internal rupture will occur, developing finally into complete fracture of the wire. If instead of a pearlitic structure we have a sorbitic one, as in fig. (10), the grains are no longer laminated but granular and can thus flow equally well in any direction, hence we get regular flow.

Now in actual practice the chief objects of the patenting process are:

(1) To get fairly large grains or crystals.

(2) To get a sorbitic structure.

These are determined by the temperature and by the rate of cooling. Both of these conditions are apt to vary and, although we may not get the extreme condition of perfectly laminated pearlite in practice, we can by improper treatment get an intermediate structure which can be most conveniently described as sorbitic-pearlite. In reality,

of course, sorbite is simply another form of pearlite but for our purpose it is convenient to call the laminated variety only, pearlite, and the entirely granular variety, sorbite. Frequently then we get a structure which is partly laminated and partly granular and when this is the case we do not get such good wire. Such a case is indeed well illustrated by the photomicrograph in fig. (10).

An extreme case is also illustrated in figs. (11 to 14), which shows the structure of a steel containing about 0.50 per cent carbon.

(1) In the annealed condition consisting of free ferrite (white) and pearlite (laminated).

(2) (1) in the drawn condition.

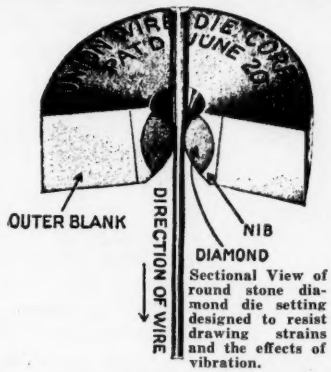
(3) In the patented condition consisting of sorbite (finely granular) and 10% ferrite (white).

(4) (3) in the drawn condition.

It will also be noticed that the magnification of these photomicrographs is 1500 diameters and that even this high power is insufficient to resolve the structure of the sorbite clearly, although it is quite high enough for the pearlite.

From the above it will be seen that the microscope is the only direct guide we have as to the patenting conditions. Ordinary mechanical tests can tell us if a wire is good or bad but they indicate the effect only, not the cause.

Turning now to another aspect of the subject, microscopic analysis is often the simplest and quickest way of finding defects in steel wire and by way of conclusion it may be of interest to illustrate this by one example. In dealing with high carbon steel wire, i. e. wire containing above 1 per cent carbon which is drawn for the manufacture of tools which have to be hardened and tempered, it is essential to see that this wire is free from decarburisation. The microscope provides a simple methodof testing this, as will be seen from fig. 43 which shows



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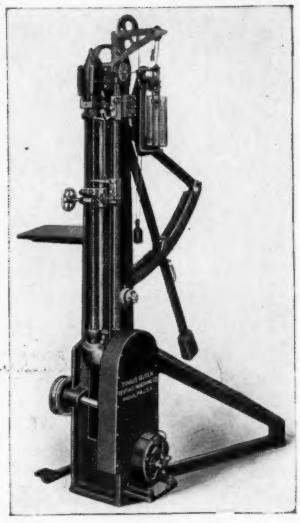

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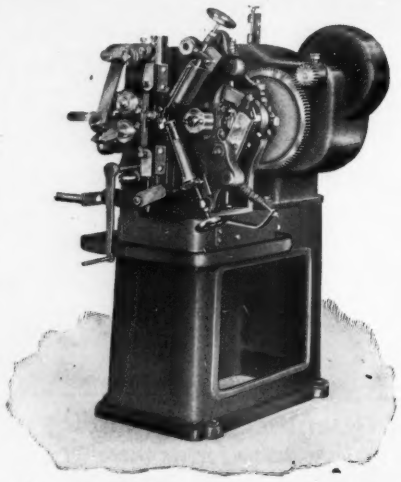

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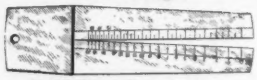
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a transverse section of a steel rod containing about 1.2 per cent carbon. The outer envelope of this rod has been badly decarburised and a wire drawn from this will not harden on the surface by quenching. The microscope tells us a great deal more about this trouble than chemical analysis can. It shows the depth of the decarburised envelope and the degree of decarburisation. There are, of course, many other instances of the use of microscopic analysis on wire, but enough have been given to show how important is this branch to the subject, and how necessary it is to enable us to understand the physical changes which occur in wire manufacture.

Silver Plating Wire

(*Continued from page 416*)

ter than the wire will stand. This is particularly important in those rolls and guides over which the wire passes during and after plating.

After leaving the plating tank the wire has a dull white appearance and is not a marketable product until further drawn to secure a polish. A very few passes will bring the wire to a high polish. The same reduction at each pass being as for copper.

In the large tank plating process the amperage carried by the wire from the point of emergence to the cathode guide may be several times the amount of current given in the underwriters tables for the safe capacity of bare copper wire. This will be necessary as the large exposed surface of the wire under the surface of the plating solution multiplied by the current density per unit area of plating surface gives a very high amperage to be carried by the wire. But this is only borne by any one point in the wire for from a fraction of a second to a very few seconds and in addition to this small time period the wire is wet and will not heat to the annealing point unless the machine is stopped with the current

on when all wire in the tank will be ruined and the machine will require re-threading.

The large tank cyanide process differs from the acid process chiefly in anode arrangement. The insoluble carbon anodes of the bottom and sides of the acid process tank are replaced by soluble silver anodes. The acid silver solution being replaced by a potassium or sodium cyanide solution. Unless the the plant employs a chemist or has an output sufficient to warrant the employment of a plater the acid process should be used as the solution is safe and the difficulty of keeping the plating solution in proper concentration is less. The arrangement of anodes in the cyanide process is very important. When horizontal wood rolls are used and the wire is passed back and forth around them the minimum anode investment is had where the anodes are between the two rows of wire and they may be suspended thus upon a wood rack the leads being encased in glass tubing the ends sealed with asphaltum or blown oil.

With this arrangement some system of agitation of the solution becomes necessary if more than one wire is to be passed through the tank at one time as the tendency of the solution is to become impoverished in silver in a horizontal layer surrounding the two parallel sets of wire and in this condition the current will seek out the path of least resistance and deposit an excess of silver upon one wire. The parallel horizontal anode arrangement is best where one wire only is plated and the ease of this single wire plating justifies the investment in tanks and anodes as against multiple wire plating.

Where more than one wire is plated at the same time in the same tank there are two methods of insuring even distribution of silver.

The wires may be passed back and forth across the length of the tank in such a manner that each wire occupies a separate longitudinal section of the tank from its neighbors permitting the anodes to be suspended vertically between the several sets of wires so that each row of anodes may be connected to a common buss bar and by means of an ammeter on each buss bar the current going to each wire is made subject to control by the simple expedient of adding or removing anodes at the points of high or low amperage.

One of the chief difficulties encountered by the American manufacturer of silver plated wire particularly where his product comes in competiton with the foreign article is the breathing test.

When a silver plated wire has been reduced from say .012″ diameter to .003″ diameter having started at .012″ diameter with a one percent plating and is then rolled to .0007″ thick and .012″ wide the silver plating will only four be millionths of an inch thick and if a spool of this material be breathed upon the moisture condensing upon the silver plate will show up any thin spots as red.

This same test is applied to music wire and because of the difference in drawing practice between European manufacturers and our own the breathing test is very hard to meet without running the silver content to a point higher than one percent.

The practice in Europe is to draw silver plated wire one pass at a time drawing the wire dry. One operator can run as high as one hundred blocks. Our practice being to use fourteen to eighteen dies in one machine with the first passes subject to a very severe scouring from the rolls. In music wire the problem is not so serious as the tapered or stepped wire machines answer very well and high quality music wire is being made in this country at the present time.

Section two of this article showing design details of the apparatus herein described together with method of computing amperage and speeds for different percentages of silver plate on various sizes of wire will appear in an early issue.

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MACHINERY—Gem Clip
J. I. Bernitz, New York.
M. A. Irmischer

MACHINERY—Insulating
American Insulating Machinery Co., Philadelphia, Pa.

MACHINERY—Nail
J. I. Bernitz, New York.
M. A. Irmischer, New York.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Pointing
M. A. Irmischer, New York.
Morgan Construction Co., Worcester, Mass.
Standard Machine Works, Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Pin & Needle
J. I. Bernitz, New York.
M. A. Irmischer, New York.

MACHINERY—Screw Wire
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Spring Making
J. I. Bernitz, New York.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Staple
J. I. Bernitz, New York.
Sleeper & Hartley, Inc., Worcester, Mass.
M. A. Irmischer, New York.

MACHINERY—Straightening
J. I. Bernitz, New York.
Hallden Machine Co., Thomaston, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
M. A. Irmischer, New York.
F. B. Shuster Co., New Haven, Conn.

MACHINERY—Stranding
J. I. Bernitz, New York.
M. A. Irmischer, New York.
New England Wire Machinery Co., New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Spooling
American Insulating Machinery Co., Philadelphia, Pa.
M. A. Irmischer, New York.
Chas. Koegel Sons, Co.

MACHINERY—Panning
American Insulating Machinery Co., Philadelphia, Pa.

MACHINERY—Testing
Herman A. Holz, New York.
Riehle Bros., Phila., Pa.
Henry L. Scott Co.
Tinius Olsen, Phila., Pa.

MACHINERY—Used
Jesse Atherton, Providence

MACHINERY—Winding
J. I. Bernitz, New York.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Wire Drawing
American Insulating Machinery Co., Philadelphia, Pa.
Broden Const. Co., Cleveland, Ohio.
Burlingame Machine Co.
Kratos Wks., N. Y. C.
Morgan Construction Co., Worcester, Mass.
M. A. Irmischer, New York.
Sleeper & Hartley, Inc., Worcester, Mass.
Superior Tool & Mfg. Co., Worcester, Mass.
The Vaughn Machinery Co., Cuyahoga Falls, Ohio.
Waterbury Farrel Fdry. & Machine Co., Waterbury

NEUTRALIZING COMPOUNDS
Oakite Products, Inc., N. Y.

REELS—Annealing
American Pulley Co., Philadelphia, Pa.
Apco-Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

PRESSES—Rivet & Bolt
M. A. Irmischer, New York.

SOAPS—Wire Drawing
R. H. Miller Co., Homer, N. Y.

SPOOLS—Wire & Cable
American Pulley Co., Philadelphia, Pa.
Apco-Mossberg Co., Attleboro, Mass.
Hubbard Spool Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TRUCKS
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

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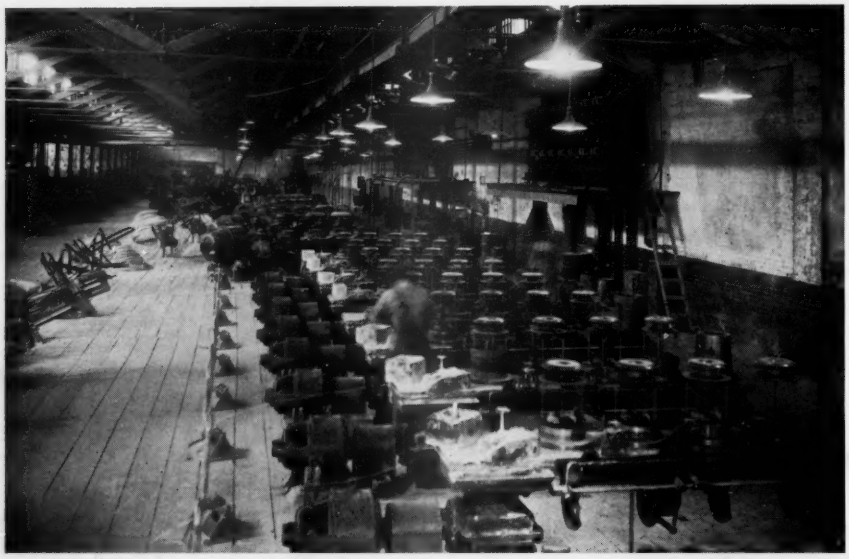

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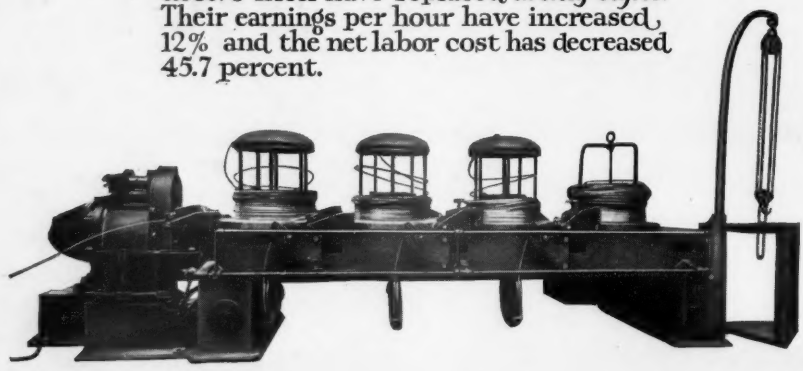

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